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(54) DISPLAY ARRANGEMENT

(71) We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of 190 Strand, London, W.C.2, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a display arrangement, and particularly to a display arrangement for presenting a two-dimensional image display by suitable scanning of an array of light emitting sources.

According to the invention there is provided a display arrangement including an array of light emitting diodes arranged in at least one straight line, means for rotating said array radially about an axis normal to the line of the array, and means for causing selective controlled light emission from any desired combination of said diodes during rotation of the array.

Gallium arsenide phosphide light emitting diodes are particularly suitable for this display arrangement, having high brightness, very fast response speeds and reproducible current-voltage characteristics. In addition, they can be prepared in a planar structure, that is, many separately controllable light sources in a single slice of single crystal material.

However, any light emitting diode array with suitable properties can be used.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 shows an array of light sources mounted on a rotor disc,

Fig. 2 shows a first input conductor arrangement for the rotor disc, with a contacting stator disc,

Figs. 3 and 4 show details of the contacting conductors on stator disc and rotor disc respectively,

Figs. 5 and 6 show respectively a second input conductor arrangement for the rotor disc with a spaced stator disc, and details of the conductors in the stator disc,

Figs. 7 and 8 show respectively stator disc and rotor disc details with a third input conductor arrangement,

Figs. 9 and 10 show an array of light sources mounted at one end face of a rotor cylinder, with alternative details of input conductor arrangements,

Figs. 11, 12 and 13 show alternative light source arrays, and

Fig. 14 shows an image converter.

Referring to Fig. 1, a rotor disc 1 of insulating material has mounted on one major surface thereof (the front face) an array of closely spaced gallium arsenide phosphide light emitting diodes 2, arranged in a line on a radius of the disc 1. There may also be mounted on the face of the disc 1 solid state components or circuits 3 each connected as indicated by conductors 4 to a light emitting diode 2, these circuits functioning for example as amplifiers or memories as will be described later.

The disc 1 is mounted so that it can be rotated in its own plane. By arranging for transmission of electrical power and light emitter modulating signals to the rotating disc a display is generated by appropriate selection and modulation of the light emitting diodes on their rotation with the disc, the display co-ordinates being polar, i.e. based on the successive instantaneous angles of the respective light emitting diodes with respect to the rotational axis and their distances from this axis.

Fig. 2 shows one arrangement for supplying electrical power and signals to the diodes 2. The rotor disc 1 attached to a shaft 5 has on its rear face a number of concentric annular conducting tracks 6 (also shown in Fig. 4), one for each diode 2 and each connected via a conductor 7 through the disc 1 to one terminal of the respective diode 2. All the other terminals of the diodes 2 are commoned for return connection for example via the shaft 5.

Coaxial with and to the rear of the rotor disc is an insulating stator disc 8 which has on its front face adjacent to the conductor track carrying rear face of the rotor disc 1 a number of conducting springs or brushes 9 (also shown in Fig. 3), one for each of the tracks 6 and spaced so as to be in contact one with each track 6. Input leads 10 to the brushes 9 permit selective transmission of modulated d.c. power to the diodes 2. To produce current through the brushes 9, a small signal can be passed through them and used to modulate the light output from the individual diodes 2 via solid state amplifiers 3 mounted on the rotor disc. In this case the conducting tracks 6 are connected to the amplifier inputs instead of directly to the diodes 2.

In an alternative friction contact arrangement, not shown, the conducting springs or brushes 9 are located on the rear face of the rotor disc 1, each connected to a different diode 2 (or to a different amplifier 3), and the annular concentric conducting tracks 6 are located on the front face of the stator disc 1, with individual input leads 10 to the stator disc tracks.

Friction contact can be entirely eliminated by the arrangement shown in Figs. 5 and 6, in which the rotor disc 1 has annular concentric conducting tracks 6 on its rear face (as shown in Fig. 4), and the stator disc 8 has corresponding annular concentric tracks 11 on its front face, Fig. 6. The two discs 1 and 8 are slightly spaced from each other so that corresponding tracks are opposite each other with a gap therebetween, and amplitude modulated high frequency signals are passed to the diode array capacitively via the gaps between the stator disc conductor tracks 11 and the rotor disc conductor tracks 6. The alternating signal is rectified either by separate diodes on the rotor disc or by using the rectifying properties of the light emitting diodes.

In yet another arrangement, not shown, a d.c. power supply is fed to the light emitting diodes on the rotor disc by two friction contacts, and an a.c. signal, fed to the rotor disc capacitively, used to modulate the power to the light emitting diodes via other circuits on the rotor disc.

Figs. 7 and 8 show another arrangement in which the rotor disc carries photoconductors and the supply to each light emitting diode is modulated by controlling light sources mounted on the stator disc.

As shown in Fig. 8, the rotor disc 1 has on its rear face a pair of annular concentric conducting tracks 12 for each light emitting diode 2, with one track of each pair (as shown in the inner track) commoned with all the other inner tracks by a conductor 13 to which d.c. power is supplied. The other track of each pair is connected to one terminal of its respective light emitting diode, the other terminals being commoned for a power return path. Overlying and interconnecting the two tracks of each pair is a layer 14 of photoconductive material.

The stator disc 8 (Fig. 7), which is arranged coaxially behind the rotor disc and spaced axially therefrom, has a radial array of light sources 15, one for each pair of conductor tracks 12 and arranged to emit light on to the respective photoconductive layer 14.

In this arrangement, the light emitting diodes 2 are controlled by causing selective light emission from the light sources 15 on the stator disc 8 to illuminate the photoconductive layers 14 so that according to the intensity of illumination the conductivity of the layers 14 is correspondingly modulated to control the power supplied to the light emitting diodes.

The array of light emitting diodes 2 may be mounted, as shown in Fig. 9, on the front end face of a rotor cylinder 21 rotatable within a coaxial stator cylinder or cage 22 on a suitable bearing arrangement 23. Around the periphery of the rotor cylinder 21 are axially spaced conductor tracks 24, one for each light emitting diode 2 and each connected to a different diode 2. As with the disc mounted arrangement, additional components or circuits may be mounted on the rotor cylinder 21.

Corresponding axially spaced conducting springs or brushes 25 on the inner surface of the stator cylinder 22 each make friction contact with a corresponding rotor conductor track 24 for d.c. power and modulating signal inputs to be applied through conductors 26 to the light emitting diode array.

Other alternatives of this cylinder arrangement are

1. for the conductive springs or brushes 25 to be mounted on the periphery of the rotor cylinder and the conductor tracks to be mounted on the inner surface of the stator cylinder 22, and

2. for both the rotor and the stator cylinder to have continuous conductor tracks (as 24) slightly spaced radially for capacitive coupling of high frequency amplitude modulated signals.

As shown in Fig. 10, the conductor tracks 24 on the rotor cylinder 21 may be arranged in pairs, one pair for each light emitting diode 2, with an inter-connecting photoconductive layer 27 on each pair. The stator cylinder 22 has a corresponding axial array of light sources 28 for selectively controlling and modulating the light emitting diodes in a manner similar to that already described with reference to Figs. 7 and 8.

In a further alternative cylinder arrangement, not shown, the rotor cylinder carrying the array of light emitting diodes on one end face is rotatable about a coaxial stator

cylinder located inside the rotor cylinder, and any of the above described input arrangement of conductors may be used in this further alternative arrangement.

Rotation of the array of light emitting diodes is achieved by any suitable means such as by drive applied to the shaft of the rotor disc or to a shaft coupled to the rotor cylinder, by a peripheral drive, or by a turbine drive.

The speed of rotation of the array is determined by the nature of the display. One type of display possible is that of a radar plan position indicator, where the speed of rotation is comparatively low, and memory circuits may be included on the rotor to maintain the display.

A straightforward alpha-numeric display is also possible, requiring selective on-off control of the individual elements of the array and a rotational speed sufficient to reduce or eliminate flicker effect.

Also possible is a television type display, i.e. where there is continuous and/or variable modulation of the array elements, the signals for the light elements of the array being derived from a conventional television scanning system and passed through a suitable decoder-encoder to convert the rectilinear co-ordinates to polar co-ordinates.

A further arrangement is that of an image converter, for example an infra-red image converter using suitable detectors. Basically this is achieved by having an array of detectors individually inter-connected with a corresponding array of light emitting elements, and rotating the two arrays in synchronism.

As shown in Fig. 14, a hollow shaft 30 interconnects a rotor disc 31, on which is an array of infra-red detectors 32, and a rotor cylinder 33 on the remote end face of which is a corresponding array of light emitting diodes 34. Each of the detectors 32 is connected by a conductor 35 through the interior of the shaft 30 and via amplifiers 36 to the corresponding light emitting diode 34. There is a lens system 37 for focussing the image on to the detectors 32, and the detectors can if required be cooled by built-in thermo-electric coolers (not shown) or by conduction to a sink 38 of cooled fluid e.g. liquid nitrogen, surrounding the shaft 30.

The power supply may be brought to the rotor cylinder 33 via slip rings 39, it may be derived from batteries built into the rotor, or the secondary winding of a dynamo can be built in to the rotor so that the power is derived from the rotational movement, shown as being imparted by peripheral drive wheel 40 driven by an electric motor 41. The arrangement is extremely compact as all members are coaxial.

Because the outer elements of the light array travel a greater distance during each revolution than those nearer the centre, their brightness would appear less if the rotation period is less than the eye's persistence of vision. To maintain the apparent brightness of the array substantially equal during rotation the drive current to the outer elements of the array is increased to increase their absolute brightness, or as shown in Fig. 11 the size of the light source is progressively increased at increasing distance from the centre, or as shown in Fig. 12 the number of light sources, of equal light emitting area, is progressively increased at increasing distance from the centre. These modifications are applicable to all the previously described embodiments.

Instead of a radial single line array, the array may comprise a diametric line, or a number of radii, for example on four radii at 90° spacing as shown in Fig. 13. More extensive arrays are also possible since the polar co-ordinates of any light element in a given array can be determined for the appropriate energisation and light modulation required for a given display.

The individual size and the spacing of the elements of the array is also determined by the type of display required, bearing in mind that the size and spacing determine the line definition of the display so that in general the spacing is made equal to the individual size of each light emitting element of the array.

WHAT WE CLAIM IS:—

1. A display arrangement including an array of light emitting diodes arranged in at least one straight line, means for rotating said array radially about an axis normal to the line of the array, and means for causing selective controlled light emission from any desired combination of said diodes during rotation of the array.

2. A display arrangement as claimed in claim 1 in which said light emitting diodes are gallium arsenide phosphide diodes.

3. A display arrangement as claimed in claim 1 or 2, in which said array comprises two or more straight lines of light emitting diodes with the or each line intersecting said axis.

4. A display arrangement as claimed in claim 1, 2 or 3 in which the diodes of the array are of equal size and are spaced apart by a distance equal to their size.

5. A display arrangement as claimed in claim 1, 2 or 3 in which said light emitting diodes have equal light emitting areas and the number of light emitting diodes on the or each said line is increased with increasing distance from the axis.

6. A display arrangement as claimed in any one of claims 1 to 5 in which said array is mounted on a planar surface of a member rotatable about said common axis, and in which the or each of said light emitting

diodes at a different radial distance from said axis is connected to a different one of an array of electrical conductors mounted on another surface of said member so as to be rotatable about said common axis.

7. A display arrangement as claimed in claim 6 in which each said rotatable conductor is connected to the or each of said light emitting diodes at a different radial distance from said axis, and in which said rotatable conductors are in continuous contact during rotation with a corresponding array of stationary electrical conductors.

8. A display arrangement as claimed in claim 6 in which each said rotatable conductor is connected to the or each of said light emitting diodes at a different radial distance from said axis, and in which said rotatable conductors are spaced during rotation from a corresponding array of stationary electrical conductors.

9. A display arrangement as claimed in claim 6 in which there is a pair of adjacent rotatable conductors for the or each of said light emitting diodes at a different radial distance from said common axis, in which one conductor of each said pair is connected to the respective light emitting diode or diodes and all the other conductors of the pairs are directly connected together, in which each said pair of conductors is interconnected by a photoconductive layer, and in which a stationary controllable light source is provided for each of said conductor pairs and arranged to emit light onto the photoconductive layer.

10. A display arrangement as claimed in any one of claims 6 to 9 in which said rotatable member is a disc, with said array of light emitting diodes mounted on one major surface thereof and said rotatable conductors mounted on the other major surface thereof.

11. A display arrangement as claimed in any one of claims 6 to 9 in which said rotatable member is a cylinder with said array of light emitting diodes mounted on an end face thereof and said rotatable conductors mounted along the longitudinal peripheral surface thereof.

12. A display arrangement as claimed in any one of claims 1 to 5 further including an array of light detector elements identical with the array of light emitting diodes and rotatable in synchronism therewith about said common axis, each of the detector elements being connected to a corresponding light emitting diode.

13. A display arrangement substantially as described with reference to Figs. 1, 2, 3 and 4, or Figs. 1, 4, 5 and 6, or Figs. 1, 7 and 8, or Fig. 9, or Fig. 10, or Fig. 11, or Fig. 12, or Fig. 13 or Fig. 14 of the accompanying drawings.

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For the Applicant.

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1241369 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

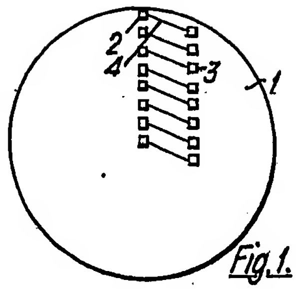

Fig.1.

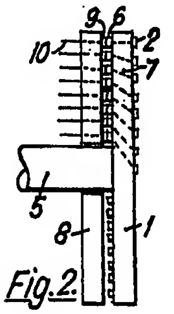

Fig.2.

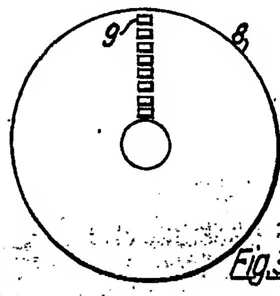

Fig.3.

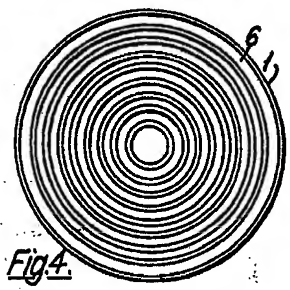

Fig.4.

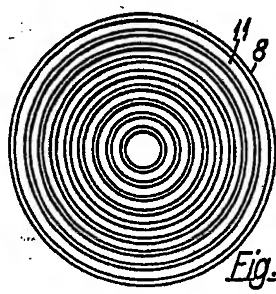

Fig.6.

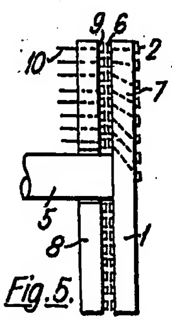

Fig.5.

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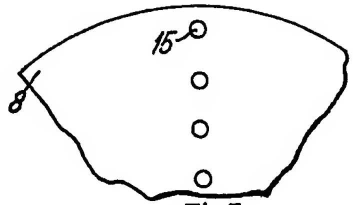

Fig. 7.

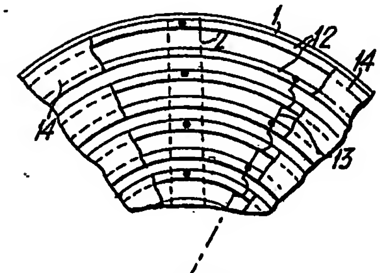

Fig. 8.

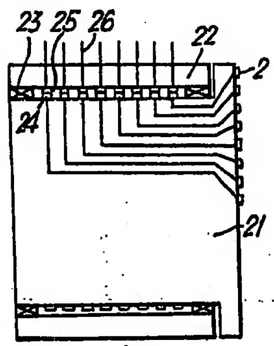

Fig. 9.

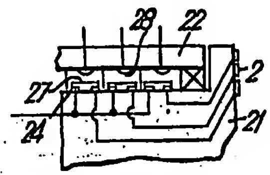

Fig. 10.

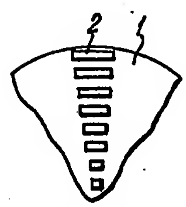

Fig. 11.

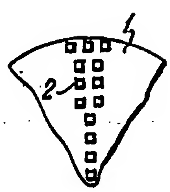

Fig. 12.

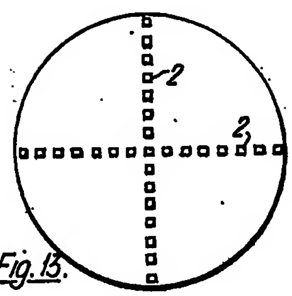

Fig. 13.

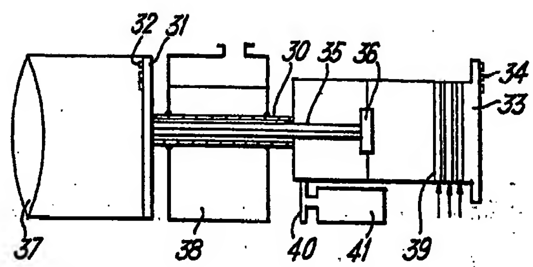

Fig. 14.